XXX.—*On* Sellaphora, *a new Genus of Diatoms.*

By C. Mereschkowsky.

[Plate IV.]

The method of studying diatoms exclusively on dead shells, which has, with few exceptions, been the practice since these little algæ first became known, will soon, I believe, have to be replaced by a broader and more scientific process, based not only on characteristics of valves and frustules, but also on those of the inner structure; and this will no doubt result in great changes in the whole science of diatomology. New genera, based on cell-contents, will be founded, new groups established, and the affinities of the diatoms will prove to be very different from what is now supposed to be true.

This conviction is the result of long and careful studies of living diatoms in which I have been engaged for the last few years, and which have given many unexpected results. Some of these results have already been described in my previous papers *, and it is my intention to discuss them more fully in an extensive work on the inner organization of diatoms which I am now preparing.

In the present note I shall give the description of a few interesting forms which I have recently found abundantly in California. They are a good illustration of the great importance of the inner structure in dealing with diatoms. Any diatomist would certainly place them in the genus *Navicula* if dead shells alone were known, and, in fact, one of these forms has always been regarded as a *Navicula*. But if their inner structure, and especially the endochrome, is taken into account, it becomes evident that they do not belong to that genus, their endochrome being very different from that of *Navicula* or any other allied genus. They represent no doubt a new genus.

One of these forms is the well-known *Navicula pupula*, Kütz., not uncommon in fresh water; the other two are new species, also not rarely to be met in salt water. The latter are small delicate forms of which I have not yet mounted specimens, so that the structure of the valves cannot be

* C. Mereschkowsky, "Études sur l'Endochrome des Diatomées," Mémoires de l'Acad. des Sciences de St. Pétersbourg, vol. xi. n. 6 (1901); "On *Okedenia*," Ann. & Mag. Nat. Hist. vol. viii. p. 415 (1901); "On *Stauronella*, a new Genus of Diatoms," *t. c.* p. 424; "Rapport préliminaire sur la Structure intérieure des Diatomées," Scripta Botanica, St. Petersburg, fasc. xix. (1902).

described; but they are easily to be distinguished one from another by the outlines of the valve, their size, their mode of living, and from all other species of Naviculoid diatoms by their inner structure.

On account of the latter it seems to me necessary to establish a new genus, which I propose to call *Sellaphora* (or "saddle-bearer"), as the endochrome, consisting of a single chromatophore-plate, is placed on the diatom like a saddle on a horse's back (Pl. IV. fig. 12).

The diagnosis of the genus is as follows:—

SELLAPHORA, gen. nov.

Valve small, symmetrical, linear to elliptical, with obtuse ends, terminal nodules distant; striæ usually fine, connecting-zone simple. Endochrome composed of one plate, resting with its narrow median part on the surface of one of the valves, with four long prolongations along the connecting-zones. Pyrenoid absent. A few elæoplasts, sometimes represented by two libroplasts *.

The endochrome is very uniform in all the species, the unique chromatophore-plate being always composed of two parts—a narrow median part (*m.* in the figures) resting on the surface of one of the valves, which may be called the dorsal valve; and four long, usually narrow, linear prolongations, turned down at a right angle to the median part and resting on both connecting-zones (*pr.* in the figures). The diagram fig. 11 represents such a plate when spread out, *m.* being the median part belonging to the valve and *pr.* the four prolongations resting on the connecting-zone. The diagram fig. 12 represents a transverse section of a frustule and shows the disposition of the plate in the frustule; the upper or dorsal valve is provided with an endochrome (*m.*), the lower or ventral valve is without one.

I shall now describe the species belonging to this genus, and then consider its affinities and its systematic position.

* The elæoplasts are oil-drops usually applied to the chromatophores, sometimes free. Retaining this name as a general term, I have found it necessary to divide the various forms of elæoplasts into three classes, as follows:—

Elæoplasts constant in number and disposition:	free, situated along the median line, two or four in number ..	libroplasts.
	applied to the inner surface or to the margins of the chromatophores, from two to four.....	placoplasts.
Elæoplasts variable in number and disposition.....		sparsioplasts.

Sellaphora pupula (Kütz.), Mer. (Pl. IV. figs. 1–5.)

Navicula pupula, Kützing, Bacill. p. 93, pl. xxx. fig. 40; Cleve, Syn. Navic. Diat. part i. p. 131. *N. pupula*, var. *genuina*, Grun. Arct. Diat. p. 45, pl. ii. fig. 53; Van Heurck, Synops. p. 106, pl. xiii. figs. 15, 16. *Stauroneis Witrockii*, Lagerstadt, Spitsb. D. p. 38, pl. ii. fig. 15 (1873) (according to Cleve perhaps *Nav. bacilliformis*). *Stauroneis tatrica*, Gutwinsky, Mater. fl. Galicyi, 1890, p. 24, pl. i. fig. 20 (according to Cleve perhaps *N. bacilliformis*). *Schizostauron ? tatrica*, De Toni, Notarisia, 1890, p. 196.

The endochrome of this species is composed of a single plate resting with its median part on the surface of one valve, which we may call the dorsal valve, the opposite one (the ventral valve) being always without an endochrome. The median or central part (*m.*) resting on the valve is narrow, extending transversely from one side of the valve to the other, and terminating in four lateral prolongations (*pr.*) which rest on both connecting-zones. When seen from the valvular aspect (figs. 1, 3, 4) the central part appears as a light yellow transverse band with concave margins and the zonal parts as two narrow dark lines along the sides of the frustule, reaching its extremities. The four prolongations are always of equal length: sometimes their upper margins are partly turned on the dorsal valve, where they appear as a light band (fig. 1, *a*) gradually passing into the central part (fig. 1, *m.*); such a case is represented in fig. 1; but usually the prolongations do not extend on to the surface of the valve. The zonal aspect shows a short dark band (fig. 2, *m.*) on one side of the frustule in its middle part, which is nothing but the median portion of the plate seen in projection: the connecting-zone is occupied by a broad light plate (*pr.*), which corresponds to the dark lines *pr.* of figs. 1, 3, 4; it never reaches the margin of the frustule opposite that which contains the dark band (*m.*). The endochrome is of a light yellow-brownish colour. No pyrenoid is to be seen.

A very peculiar feature of this species consists of the two free elæoplasts, or libroplasts as I propose to call them (fig. 1, *lp.*). They are situated along the median line of the valve, one in the upper, the other in the lower half of the frustule, and, as can be seen from fig. 2, they both rest on one valve, which is always the ventral. These libroplasts are absolutely constant; I have found them in all the numerous specimens which I have had the opportunity of observing, and they are invariably two in number, always occupying the same position. It is as good and constant a characteristic of this species as the disposition of striæ or the form of the terminal nodule. The shape of the libroplasts is rarely a

regular sphere; usually they are more or less irregular, angular, sometimes elongated. A very interesting peculiarity of these libroplasts is their constant motion. They are continuously wandering along the median line, now approaching the extremities, now reaching the border of the central part of the plate. The two little crosses in fig. 4 mark the limits of their wanderings. These movements do not proceed in a regular way, but are rather irregular, with sudden changes in both directions.

The same kind of libroplasts are to be found in many diatoms; they occur in several species of *Navicula* and *Caloneis*, are common amongst *Diploneis* and *Amphora*, and are never absent in *Tropidoneis*, *Pleurosigma*, and *Toxonidea*; usually also they have the same kind of movements.

The central plasma is not well marked, being hidden by the median part of the chromatophore; it can be better seen in the zonal aspect, where it appears as a narrow transverse band (fig. 2, *pl.*).

In order to give an idea of the structure of the valve of at least one species of this genus I have reproduced here the figure of a valve of *S. pupula* after Grunow* (fig. 5).

As already stated, I have observed a great number of living specimens of this species in fresh water in Los Angeles (California).

Some measurements in millimetres are:—

Length:	0·021	0·024	0·0276	0·033	0·033
Breadth of valve:	0·0086	0·0086	0·0095	0·0095	0·0095

Cleve† distinguishes the two following varieties:—

Var. **rectangularis**, Greg. (M. J. ii. pl. iv. fig. 17, 1854; Grun. Arct. D. p. 45).

Var. **bacillarioides**, Grun. (Cl., Grun. Arct. D. 1880, p. 45).

Sellaphora Borscowii, sp. n. (Pl. IV. figs. 6–10.)

Valve narrow, linear-lanceolate or almost linear, slightly attenuated at the ends, which are a little produced, broad and roundly truncate. Terminal nodules distant from the ends. Striæ very fine. Frustule delicate, regularly quadrangular, with truncate ends and rounded angles. Lives in gelatinous *Schizonema*-like tubes. Length 0·019–0·031 mm., breadth of valve 0·0052–0·0067 mm.

Marine: San Pedro (California).

* Cleve & Grunow, Arctische Diat. pl. ii. fig. 53.

† Cleve, Syn. Navic. Diat. part i. p. 131.

This is a small and very delicate form, the frustules living in long, very thin, gelatinous tubes, in which they are disposed in several rows. Whether the tubes are ramified or not I cannot say, as I have not seen entire colonies. When out of the tubes the frustules move very slowly, and, as I ascertained by turning them on both sides, they move on whichever valve, the dorsal or the ventral, they are lying.

The endochrome is composed, as usual in this genus, of one plate, resting by its narrow median portion (*m.*) on the dorsal valve, with the margins extended in four narrow linear prolongations (*pr.*) which rest on both connecting-zones. The median or valve part is thicker than the prolongations, as can be seen by comparing figs. 7 and 8, *m.*, with figs. 8 and 9, *pr.*; and this part is a little elevated, *i. e.* nearer to the dorsal valve than the prolongations (figs. 7, 8). In the valve-face (figs. 6, 9) these latter appear as very narrow and usually short dark lines, never reaching the ends of the frustule; in the zonal aspect they are seen as narrow linear bands, with rounded ends and straight margins occupying only a small part of the connecting-zone, not reaching either the dorsal or the ventral margin of the frustule; from the latter they are always more distant than from the former. The ventral part of the frustule is therefore entirely colourless. The colour of the endochrome is light yellow, with a greenish tint. Pyrenoids absent. Elæoplasts variable; usually there are two small ones applied to both margins of the median part along the central line (fig. 6), frequently there are four (fig. 9), sometimes none. Two very small elæoplasts are also occasionally to be found at the ends of the prolongations (fig. 8). The central plasma is applied to the inner surface of the median portion of the chromatophore (fig. 3, *pl.*) as a hemispherical protuberance, containing in its centre a nucleus (*nc.*); sometimes the plasma reaches the ventral valve (fig. 7).

This species is rather common in some of the lagunas near San Pedro (California). It may be considered a marine species, the water in these lagunas connected with the open sea being quite saline.

The species is named after a distinguished Russian diatomist, Professor E. Borsçow, author of a very valuable work on the Diatoms of West Russia *, unfortunately interrupted by his early death.

* E. Borsçow, 'Die Süsswasser Bacillarien (Diatomaceen) des westlichen Russlands': Kiew, 1873.

Sellaphora elliptica, sp. n. (Pl. IV. figs. 13–16.)

Valve elliptical to linear-elliptical, with subcuneate ends; terminal nodules distant; median line accompanied by a narrow dark space, broadening towards the centre, representing probably the axial area; striæ fine. Frustule very narrow, linear, with rounded angles. Length 0·012–0·0245 mm., breadth of valve 0·006–0·009 mm., breadth of girdle-face 0·0036–0·0055 mm.

Marine: San Pedro (California).

This species is easily distinguished from the preceding one by the form of the valve, which is much broader, elliptical, in larger forms almost linear (fig. 15); towards the ends the valves are always a little cuneate. The frustule is usually very narrow.

The endochrome is of the same type as in the two preceding species; the median portion is narrow, often asymmetrical, being broader on one side (fig. 15) and not thicker than the four prolongations. The latter are usually more or less short, only rarely attaining the summit of the frustule as in fig. 15. The zonal prolongations are much broader than in *S. Borscowii*; sometimes they cover the entire surface of the connecting-zone (fig. 14), but as a rule they do not reach the ventral side (fig. 16). Colour of endochrome yellow-brown, of a more or less dark tint. Pyrenoids absent. Elæoplasts usually two in number, variable as to their disposition, either at the extremities of the prolongations and along their median line or nearer to the centre (figs. 15, 16); they are never free, *i. e.* of the kind which I call libroplasts.

This is a free-living species; its movements are rather fast, proceeding in a straight line with continuous fluctuations. It is not rarely to be met in a laguna at Long Beach, near San Pedro (California), where the water is usually quite saline; in winter time when it rains (which seldom happens in California) the water becomes of course a little brackish for a while.

Sellaphora (?) bacilliformis (Grun.), Mer.
(Pl. IV. fig. 17.)

Navicula bacilliformis, Grun., Cleve & Grunow, Arct. Diat. 1880, p. 44, pl. ii. fig. 51; Van Heurck, Synops. pl. xiii. fig. 11; Pantocksek, iii. pl. iii. fig. 49.

I give the figure of a valve of this species after Grunow (Arct. Diat. pl. ii. fig. 51). When compared with fig. 5, representing a valve of *S. pupula*, one can easily see the

great resemblance of both species in every respect except in the terminal nodules, which in *S.* (?) *bacilliformis* are not transversely expanded. There can be hardly any doubt that this species also belongs to the genus *Sellaphora* and that its endochrome will prove to be of the same kind as in other species of this genus.

It seems very probable that many other species of *Navicula* belonging to Cleve's group Mesoleiæ (and perhaps Bacillares also, established by Cleve*), and especially the so-called *Dickieia*, will also have to be placed in this genus. In my paper "Études sur l'Endochrome des Diatomées" I have described one representative of this group (p. 17, pl. iii. fig. 22)†, which is characterized by very short chromatophores, such as do not usually occur in the genus *Navicula*, while in the genus *Sellaphora* short chromatophores are not uncommon (figs. 9, 10, 13). It is true that the median valve part of the plate is missing in my figure, but I may possibly have overlooked it, as at the beginning of my studies on diatoms, when these observations were made, I did not pay much attention to the endochrome.

The following brief synopsis of the forms belonging to the genus *Sellaphora* will facilitate their distinction and serve as a convenient key for their determination:—

Striæ distant in the middle of the valve (12–15 in 0·01 mm.): freshwater forms.	
Terminal nodules with transverse expansions. Two libroplasts; lateral prolongations of the chromatophore very elongated	*S. pupula* (Kütz.), Mer.
Valve linear, with broad subrostrate ends	v. *rectangularis*, Greg.
Valve linear, with rounded ends	v. *bacillarioides* (Grun.).
Terminal nodules without expansions	*S.* (?) *bacilliformis* (Grun.), Mer.
Striæ fine everywhere; no libroplasts: marine forms.	
Valve narrow, linear: frustules enclosed in gelatinous tubes	*S. Borscowii*, Mer.
Valve elliptical; frustules free	*S. elliptica*, Mer.

* Cleve, Syn. Navic. Diat. part i. pp. 127 & 136.

† It is erroneously named in my paper *Amphipleura pellucida*. Having it now in a slide, I can easily see that it is not an *Amphipleura*, but a *Dickieia*; and as the form of the valve is very different from *D. ulvacea*, the only species which Cleve has admitted in his synopsis, it represents probably a new species which might be called *Navicula* (*Dickieia*) *oblita*, Mer. The two libroplasts of this species resemble those of *Sellaphora pupula*.

On the Affinities of the Genus Sellaphora.

In order to show the right place of this genus in the system of diatoms it is necessary to give here a short exposition of a new classification of the Raphidian diatoms, based on the inner structure, and especially on the endochrome. This system will be more fully explained in my paper "Rapport préliminaire sur la Structure intérieure des Diatomées." For the present I simply give its main features.

I divide the Rhaphideæ into three groups:—

I. Archaideæ.
II. Monoplacatæ.
III. Polyplacatæ.

The Archaideæ represent the central group from which have sprung on one side the two remaining groups of Raphidian diatoms (Monoplacatæ and Polyplacatæ) and on the other the Carinatæ (Surirelloideæ, Nitzschioideæ); the actually living representatives of the Archaideæ are the genera *Auricula*, *Amphiprora*, *Amphoropsis* (s. emend.), *Epithemia*, *Stauronella* *.

The Polyplacatæ are characterized by a symmetrical disposition of the plates, usually two in number (Diplacatæ or Naviculaceæ), sometimes four (Tetraplacatæ, including the genera *Scoliotropis*, *Achnanthidium*, *Mastogloia*, and certain species of *Amphora*), or even more, as in the Okedenieæ †. The Pleurotropideæ (comprising two sections or families, Pleurosigmeæ and Tropidoideæ) form a separate division of the Polyplacatæ representing an independent branch of the common stem ‡.

Finally, we have the Monoplacatæ, which are characterized by a single plate disposed asymmetrically. This group is mainly composed of such forms as *Cymbella*, *Gomphonema*, *Rhoicosphenia*, *Anomœoneis*, and *Brebissonia*, in which the plate is situated on the dorsal connecting-zone with a pyrenoid in its centre. On account of this latter characteristic I call this group, which is a very natural one, Pyrenophoreæ. There are, however, several other groups of Monoplacatæ besides the Pyrenophoreæ, as, for instance, the Cocconcideæ

* See my note "On *Stauronella*, a new Genus of Diatoms," Ann. & Mag. Nat. Hist. 1901, vol. viii. p. 424.

† See my note "On *Okedenia*," *t. c.* p. 415.

‡ The inner structure of Pleurosigmeæ and Tropidoideæ leaves no doubt as to their near relationship. The Tropidoideæ have nothing in common with *Amphiprora* or the Nitzschieæ, and are not related to them in any respect.

or Heteroideæ, which represent a lateral branch composed of degenerated forms (*Cocconeis* and *Microneis*, Cleve). Another group is formed by the new genus *Catenula* *, characterized by the plate being placed not on the dorsal but on the ventral connecting-zone and by the absence of a pyrenoid. And, finally, we have a fourth group of the Monoplacatæ represented by *Sellaphora*, where the plate rests not on the connecting-zone, but on the surface of one of the valves.

The main idea of this new system lays in the division of the Raphidian diatoms (other than the Archaideæ) into two entirely independent principal branches, one with a single asymmetric plate and the other with two or more symmetric plates. It seems to me quite impossible to admit that in the course of evolution of diatoms forms with two or more symmetric plates could have originated from forms with one asymmetrical plate or *vice versâ*, and this not once but several times. The supposition that all Monoplacatæ have had a common ancestor with a single asymmetrical plate is much more natural and in conformity with the constancy of the number and position of chromatophores in diatoms. The single plate may have changed its position in the frustule and lost its pyrenoid, thus producing the groups Cocconeideæ, Catenulaceæ, and Sellaphoreæ.

The genus *Sellaphora* is therefore to be regarded as a separate group (family) of the Monoplacatæ.

The new classification of the Raphidian diatoms is made clear by the following table:—

RAPHIDEÆ.

I. **Polyplacatæ.**
- A. Diplacatæ.
  - 1. Naviculaceæ (*Navicula*, *Diploneis*, *Caloneis*, &c.), with two zonal plates.
  - 2. Cleviaceæ (*Clevia* †), with two plates resting on both valves.
- B. Tetraplacatæ.
  - 1. Scoliotropideæ (*Scoliotropis*, *Achnanthidium*, *Achnanthes*).
  - 2. Mastogloieæ.
- C. Okedenieæ.
- D. Pleurotropideæ.
  - 1. Pleurosigmeæ.
  - 2. Tropidoideæ.

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* See my note "Sur *Catenula*, un nouveau Genre de Diatomées," Scripta Botanica, St. Petersburg, 1902, fasc. xix.

† Under this name I propose to unite the Naviculeæ Punctatæ and Lyratæ, which have all two plates placed on the surface of both valves. The genus *Pseudoamphiprora*, which has a similar structure, belongs also to the family Cleviaceæ.

II. **Monoplacatæ.**

A. Pyrenophoreæ (*Cymbella*, *Gomphonema*, *Rhoicosphenia*, *Anomœoneis*, *Brebissonia*, *Navicula dicephala*).
B. Catenulaceæ (*Catenula*).
C. Sellaphoreæ (*Sellaphora*).
D. Cocconeideæ or Heteroideæ, s. em. (*Cocconeis*, *Microneis*).

III. **Archaideæ** (*Auricula*, *Amphoropsis*, *Amphiprora*, *Epithemia*, *Stauronella*).

28th September, 1901.

EXPLANATION OF PLATE IV.

Fig. 1. *Sellaphora pupula* (Kz.), Mer. Valve. *m.*, median part of the single chromatophore; *pr.*, its four lateral prolongations resting on the connecting-zones; *a*, the margin of the latter turned up on the surface of the valve; *lp.*, libroplasts. Fresh water, California. $\frac{1200}{1}$.

Fig. 2. Ditto. Girdle-face. *pl.*, central plasma; *m.*, median part of the plate seen in projection; *pr.*, the lateral prolongations of the latter. $\frac{1200}{1}$.

Fig. 3. Ditto. Valve; a typical specimen. *lp.*, *m.*, and *pr.*, see fig. 1. $\frac{1200}{1}$.

Fig. 4. Ditto. Valve of a small individual. $\frac{1200}{1}$.

Fig. 5. Ditto. Valve, after Grunow (Arct. Diat. pl. ii. fig. 53). $\frac{900}{1}$.

Fig. 6. *Sellaphora Borscowii*, Mer. Valve, very typical. *m.*, median part of the chromatophore, with the two ekeoplasts; *pr.*, its four lateral prolongations seen in projection. Marine, California. $\frac{1200}{1}$.

Fig. 7. Ditto. Girdle-face of the same individual in a slightly oblique position. *m.*, median part; *pr.*, prolongations of the chromatophore. $\frac{1200}{1}$.

Fig. 8. Ditto. Another girdle-face. *pl.*, central plasma; *nc.*, nucleus. $\frac{1200}{1}$.

Fig. 9. Ditto. Valve. $\frac{1200}{1}$.

Fig. 10. Ditto. Valve; the smallest individual observed. $\frac{1200}{1}$.

Fig. 11. Diagram of a chromatophore-plate of a *Sellaphora* with unfolded margins. *m.*, median part resting on the surface of the valve; *pr.*, the four prolongations resting on the connecting-zone.

Fig. 12. Diagram representing a transverse section of a frustule of *Sellaphora*. *m.*, median part of the chromatophore resting on the dorsal valve; *pr.*, prolongations resting on the connecting-zones.

Fig. 13. *Sellaphora elliptica*, Mer. A typical valve. Marine, California. $\frac{1200}{1}$.

Fig. 14. Ditto. Girdle-face of the same individual; not very typical. $\frac{1200}{1}$.

Fig. 15. Ditto. Valve with unusually elongated lateral prolongations of the chromatophore-plate. $\frac{1200}{1}$.

Fig. 16. Ditto. A typical girdle-face.

Fig. 17. *Sellaphora* (?) *bacilliformis* (Grun.), Mer. Valve, after Grunow (Arct. Diat. pl. ii. fig. 51).

XXXI.—*On a Hermaphrodite Example of the Herring* (Clupea harengus). By Thomas Southwell.

Dr. Günther remarks ('Study of Fishes') that instances of so-called hermaphroditism have been observed in the codfish, some Pleuronectidæ, and in the herring; but I believe that in the latter species such instances are very rare. It may therefore be worth recording an example recently sent me by Mr. Patterson, of Yarmouth, for examination.

Mr. Yarrell exhibited the bi-sexual organ of a herring at a meeting of the Zoological Society on the 23rd September, 1845 (P. Z. S. 1845, p. 91); there is also a description of a similar compound sexual organ in this fish by Dr. A. J. Smith in the 'Journal of Anatomy and Physiology,' 1870, vol. iv. p. 258; in addition to these, Dr. Day (Brit. Fishes, ii. p. 219) refers to a third example of the same kind recorded by Malm (Œfv. Ak. Förh. 1876, pl. v.); this latter description I have not seen.

The example sent me, which had been removed from the fish, was of the usual form of the complete roe; it was 130 millim. long; the anterior portion, consisting of the female organ, was 95 millim. in length and 30 millim. at its greatest depth. The male organ, or milt, occupied the posterior portion of the abdominal cavity and was 35 millim. in length, tapering off sharply towards its termination. The female roe was divided transversely into two distinct lobes, each contained in the usual investing membrane, but the male portion (milt) was in a single mass, the division between the two organs being more or less vertical, but the former extending furthest to the rear along the dorsal portion. The lobes of the female organ thinned out towards their posterior outer margins and a portion of the milt obtruded between them in the form of a wedge. Both bodies were fully matured and had a healthy appearance, but owing to their having been removed from the fish, which had previously been smoke-dried, a more minute examination was impossible.